Status of SHMS Electromagnetic Calorimeter

Status in January 08
What have been done since then
Outlook

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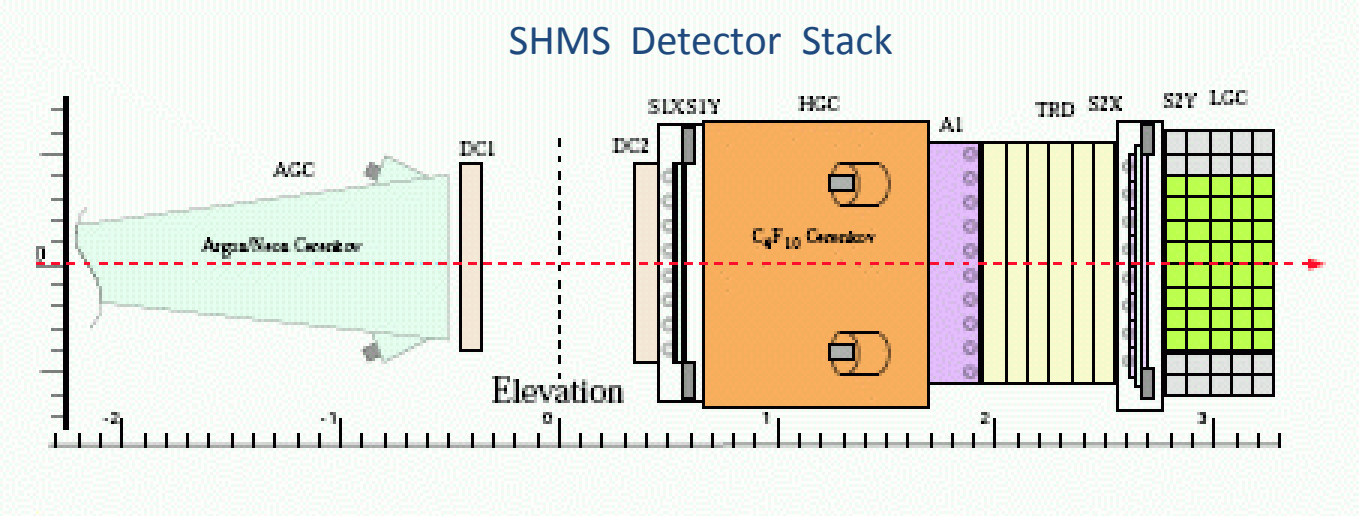
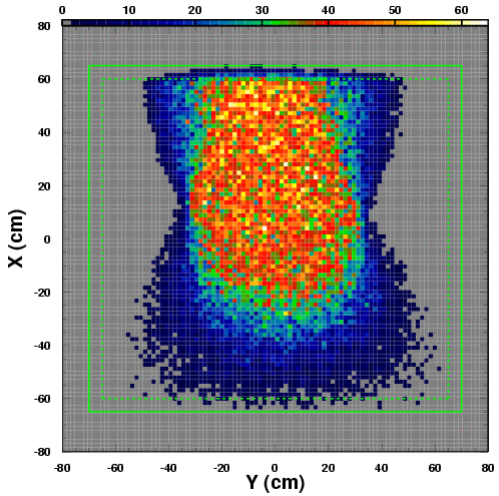
Hall C Collaboration Meeting, August 2008

Position and dimensions of the calorimeter

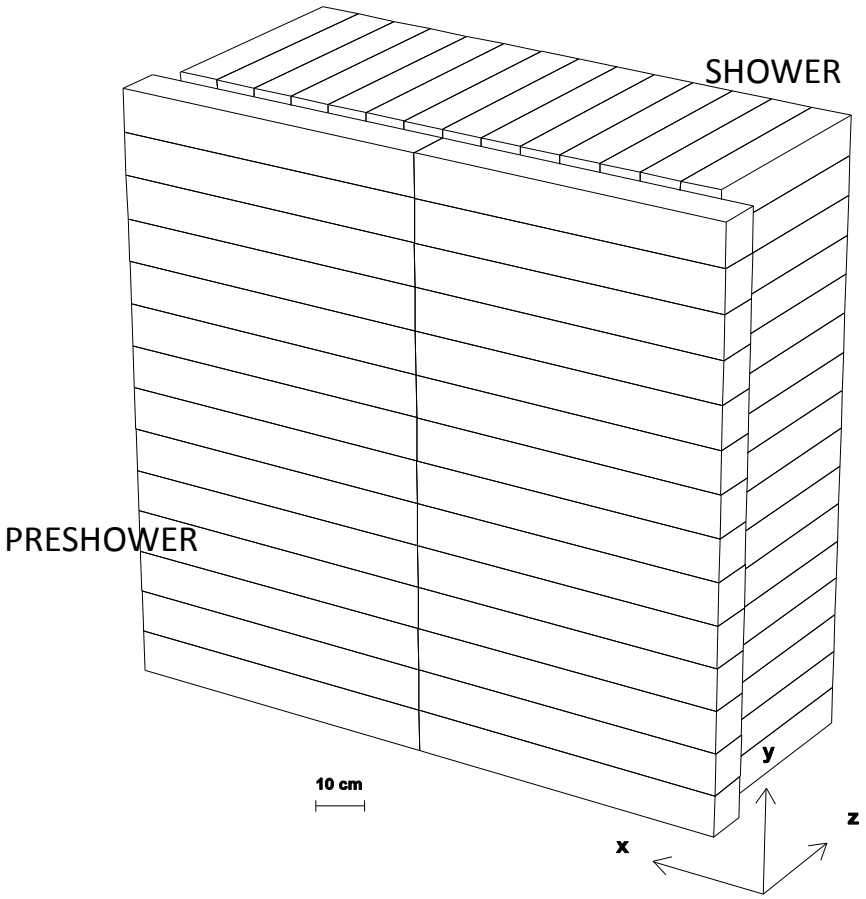




Beam envelope at the back of calorimeter

Nominal SHMS Lead Glass Calorimeter sizes:	
Effective Area (cm^2)	120x130
Thickness (Rad. L.)	~20

Construction of the calorimeter



PRESHOWER:

Number of blocks	28
Blocks from	SOS
Block size (cm^3)	10x10x70
Lead Glass type	TF-1
Thickness (Rad.L.)	3.6

SHOWER:

Number of blocks	224
Blocks from	HERMES
Block size (cm^3)	9x9x50
Lead Glass type	F-101
Thickness (Rad.L.)	18.0

CALORIMETER:

Number of channels	252
Effective Area (cm^2)	116x134
Thickness (Rad.L.)	21.6

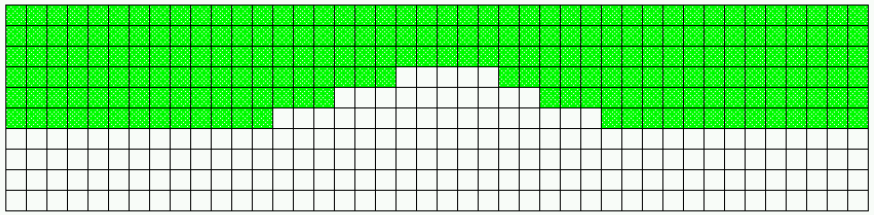
Lead Glass:

Radiation Length (cm):	
TF-1	2.74
F-1	2.78
Density (g/cm^3)	3.86
Refractive Index	1.65

What is done for now

- 240 HERMES calorimeter modules moved to Jlab.
  ➔ February'08.
- General revision of HERMES modules.
  (No any visible damage during transportation !)
  ➔ March-May'08
- Quantum Efficiency studies on 7 randomly selected PMT's from HERMES modules.
  ➔ May-July'08
- Attenuation length studies on 10 blocks from HERMES calorimeter.
  ➔ May-July'08
- Quantum Efficiency studies on 2 new XP3461 type PMT's.
  ➔ May-July'08

Block arrangement



Block selection in HERMES

279	769	62	708	256	711	450	827	555	52	835	401	831	71
375	110	547	213	261	444	214	106	120	405	234	135	435	371
821	4	64	297	100	58	294	329	22	284	13	657	388	563
458	429	582	183	878	498	197	21	879	408	483	412	174	101
728	856	233	12	566	260	171	559	104	326	532	768	721	210
407	637	306	107	585	681	66	877	712	481	791	836	527	218
519	343	383	245	849	56	801	69	251	380	732	333	112	341
63	20	55	358	879	665	399	647	240	346	840	695	147	140
78	741	46	236	446	875	878	701	814	593	238	434	539	659
567	167	302	344	424	812	817	427	125	347	489	145	775	421
323	51	7	25	226	300	880	459	267	501	680	658	185	724
805	16	648	786	672	396	116	206	784	819	67	662	456	42
30	98	211	280	632	288	460	620	572	5	115	353	676	313
423	374	175	439	638	604	510	244	169	603	36	748	200	475
384	81	180	314	461	818	360	503	599	848	9	90	254	373
441	471	349	163	796	400	222	760	345	755	661	305	628	842

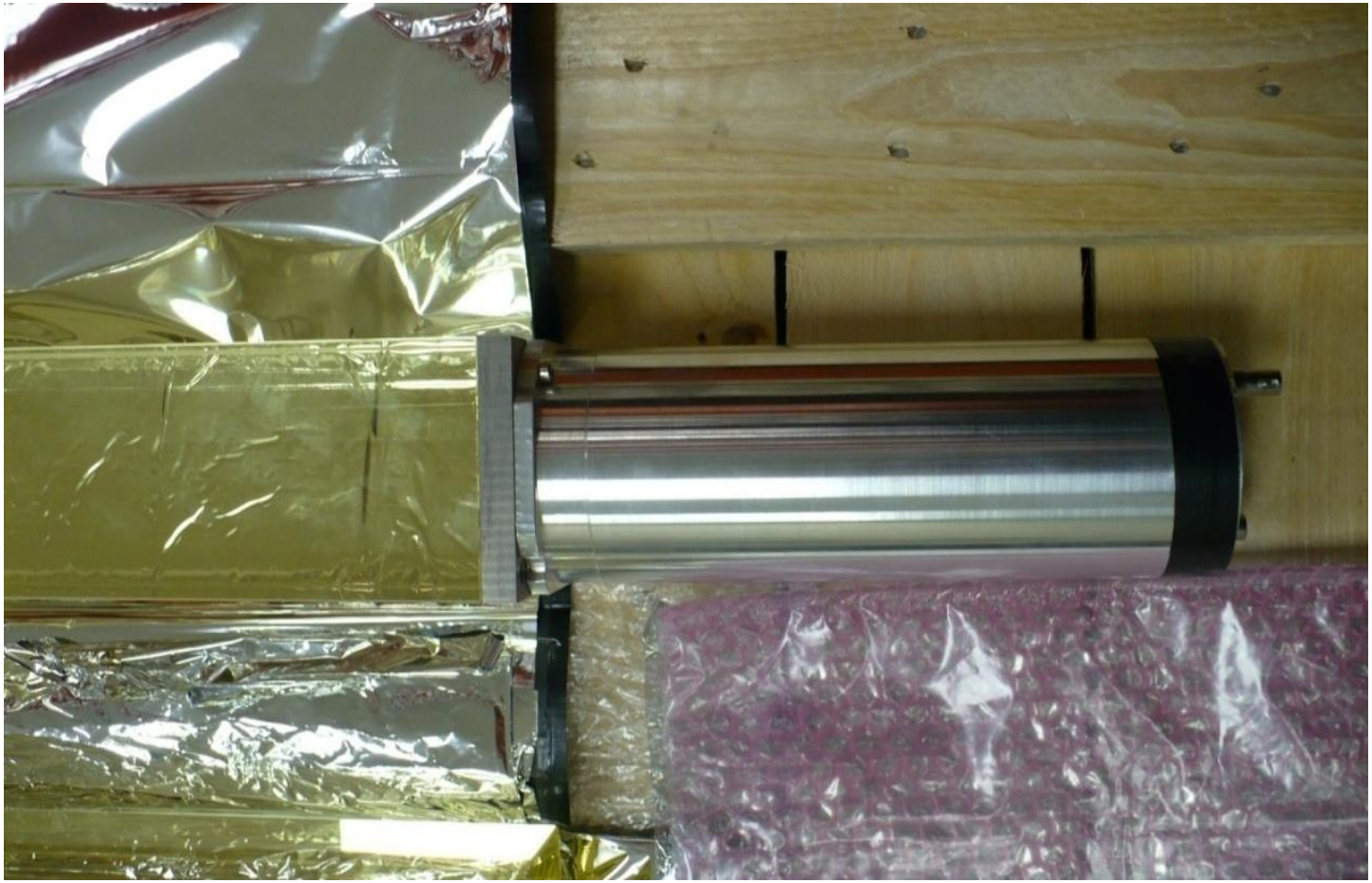
The less radiated blocks in the center of SHMS calorimeter

HERMES Modules in e-building

HERMES module construction

- F101 type lead glass blocks
- Block dimensions 9 cm × 9 cm × 50 cm
- Module length including PMT+HV base housing 29.5 inch
- Wrapped with 50 µm thick aluminized mylar, covered with 125 µm thick tedlar

HERMES module construction

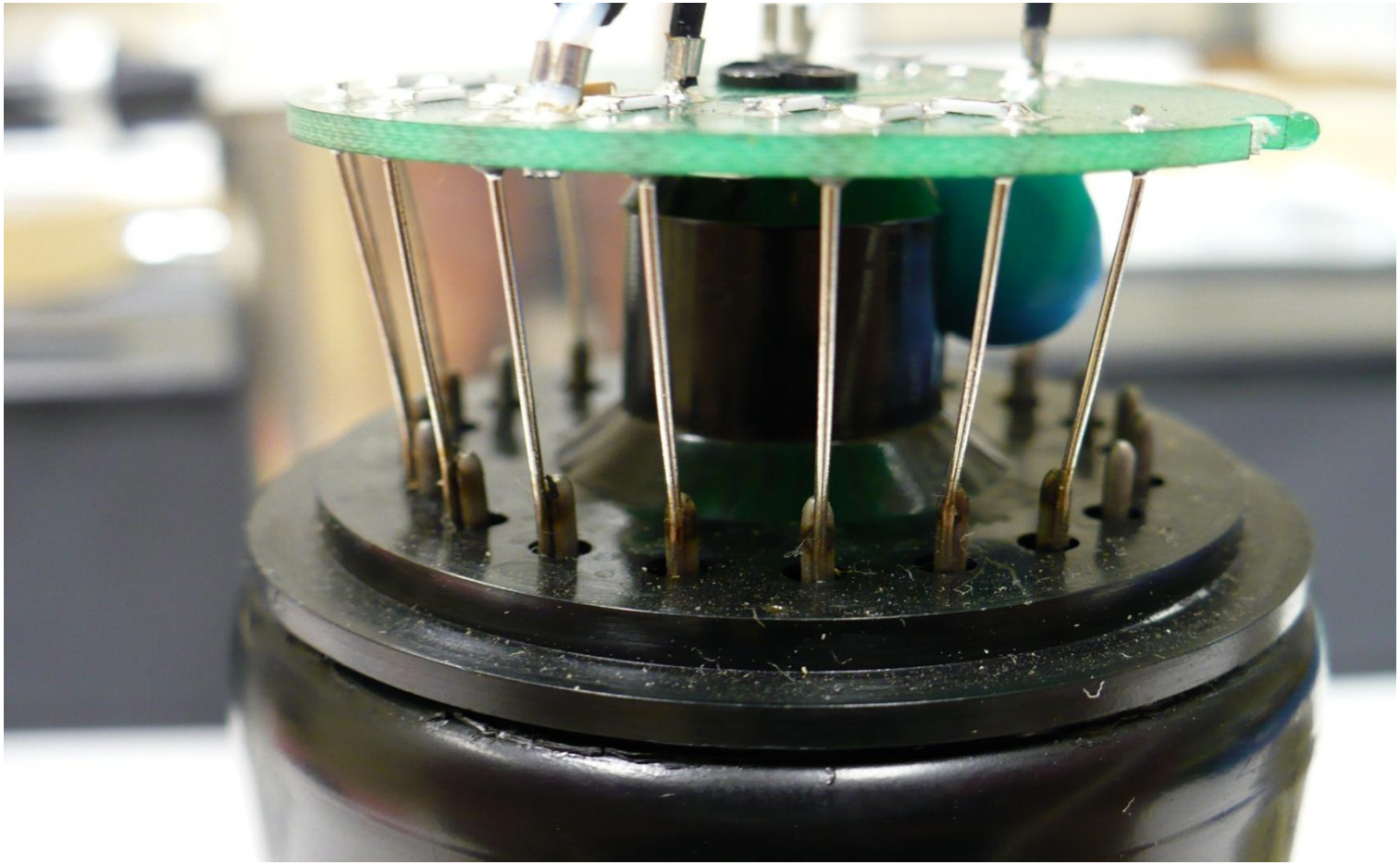


- Aluminum PMT housing mounted on flange glued to the block
- The flange made of titanium to match F101 thermal expansion

HERMES module construction

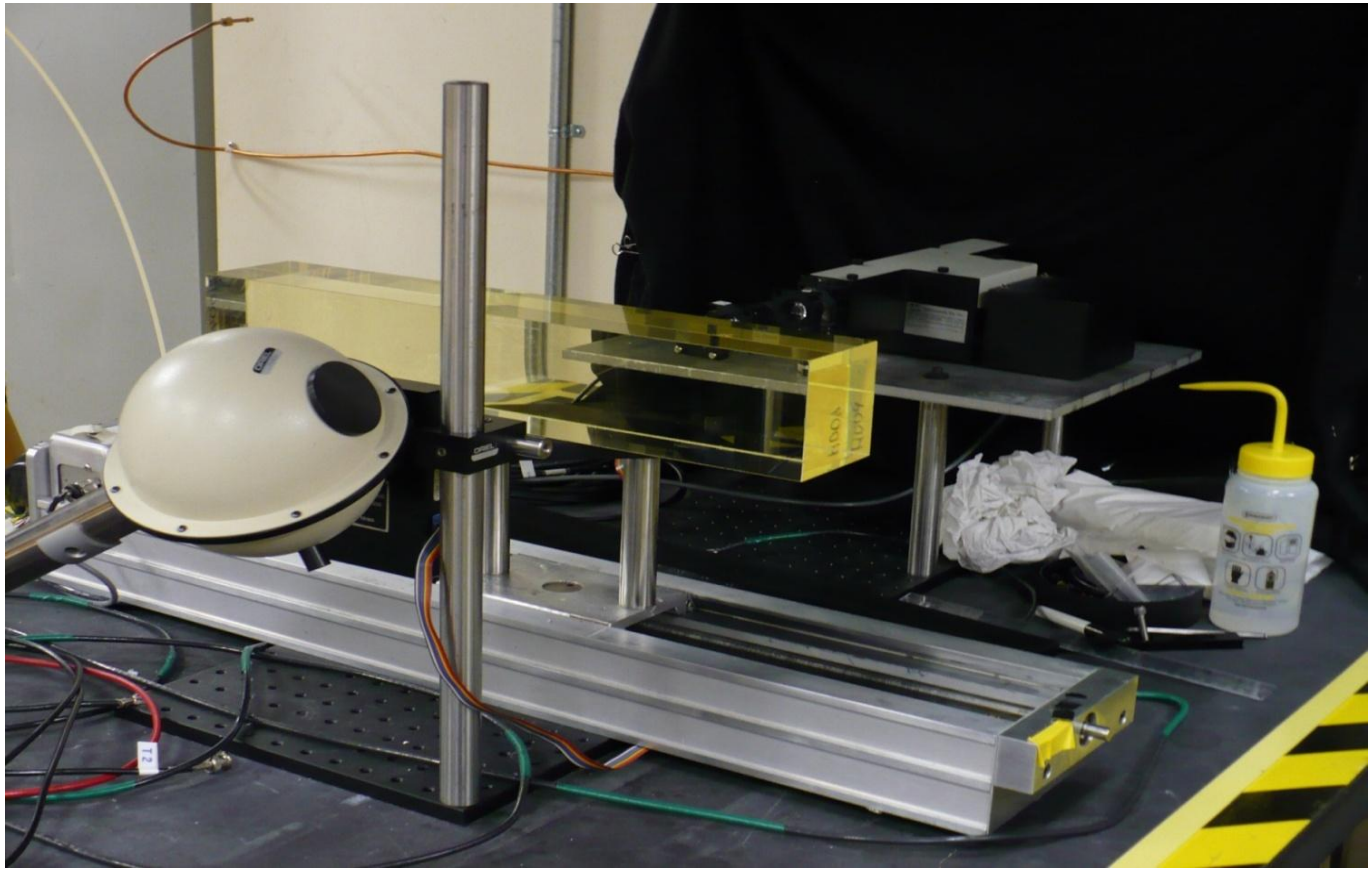
- Ø7.5 cm XP3461 PMT glued to block with SILGARD-184 (N=1.41)
- 1.5 mm thick μ-metal magnetic shield and 2 layers of teflon for electrical insulation of the PMT

HERMES HV Divider



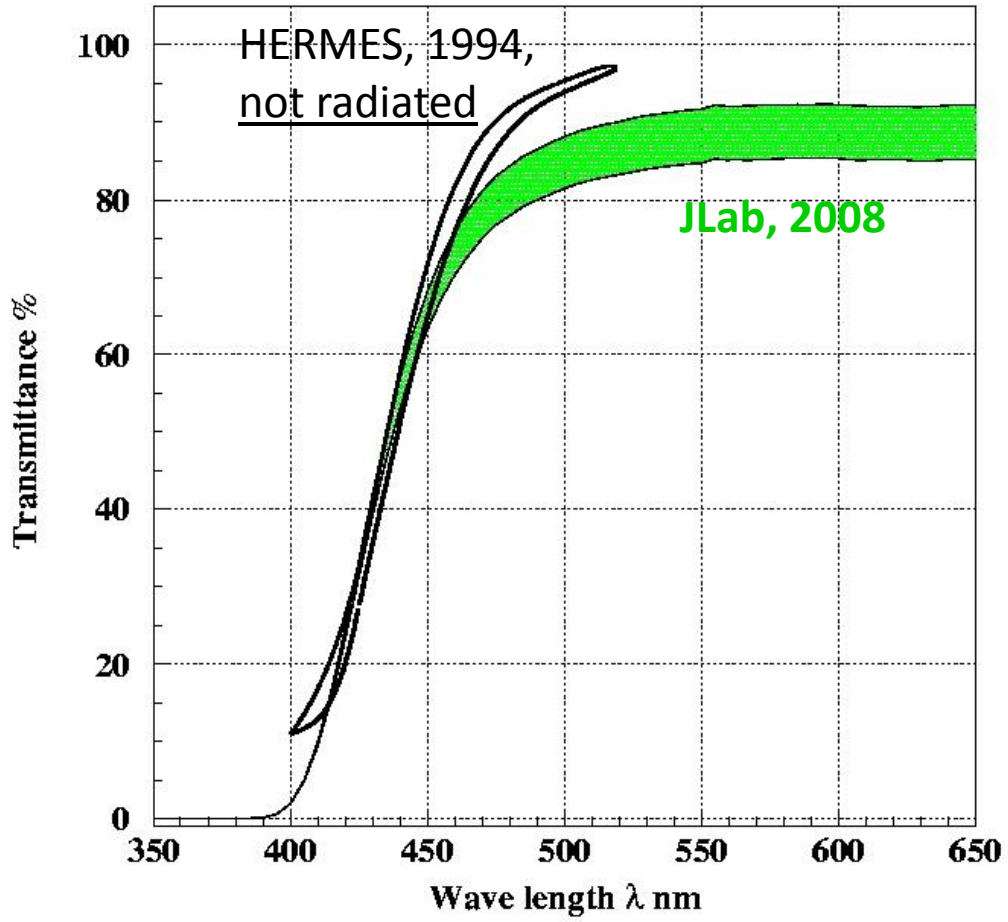
- Surface mounted HV divider, operated at negative HV 1.3 - 1.6 kV
- Divider pin-to-pin soldered to PMT, no socket, hard to replace if any problem

Set-up for lead glass optical studies



- Readily provided by Carl Zorn
- Wave-length scan from 200 to 700 nm in 10 nm steps
- 2 measurements, with and without lead glass

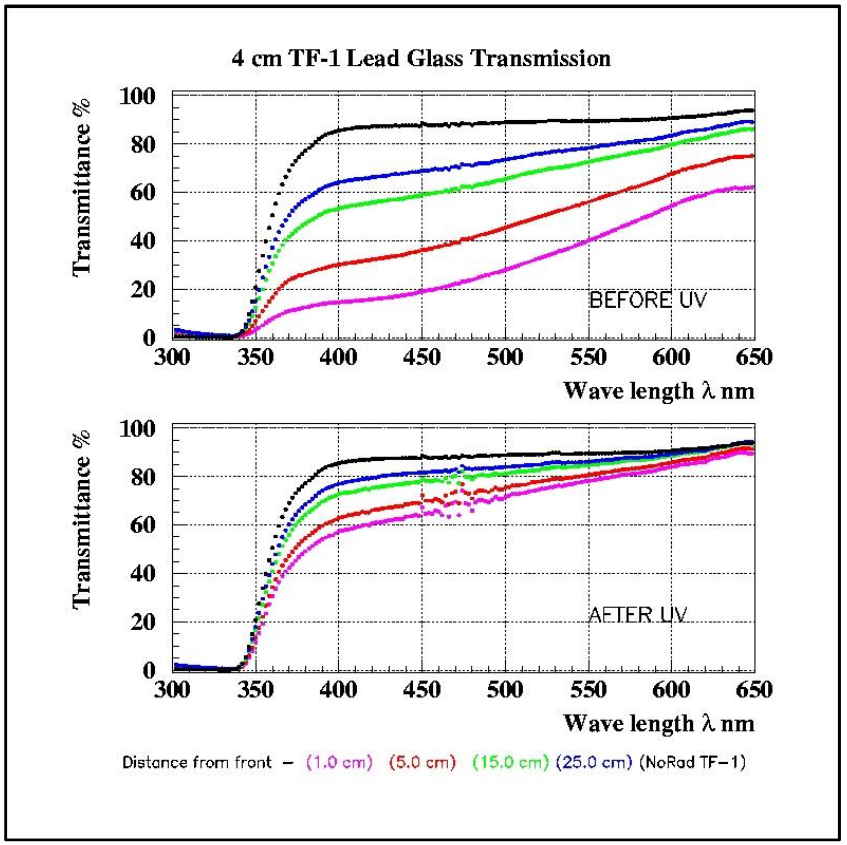
HERMES blocks transmittance

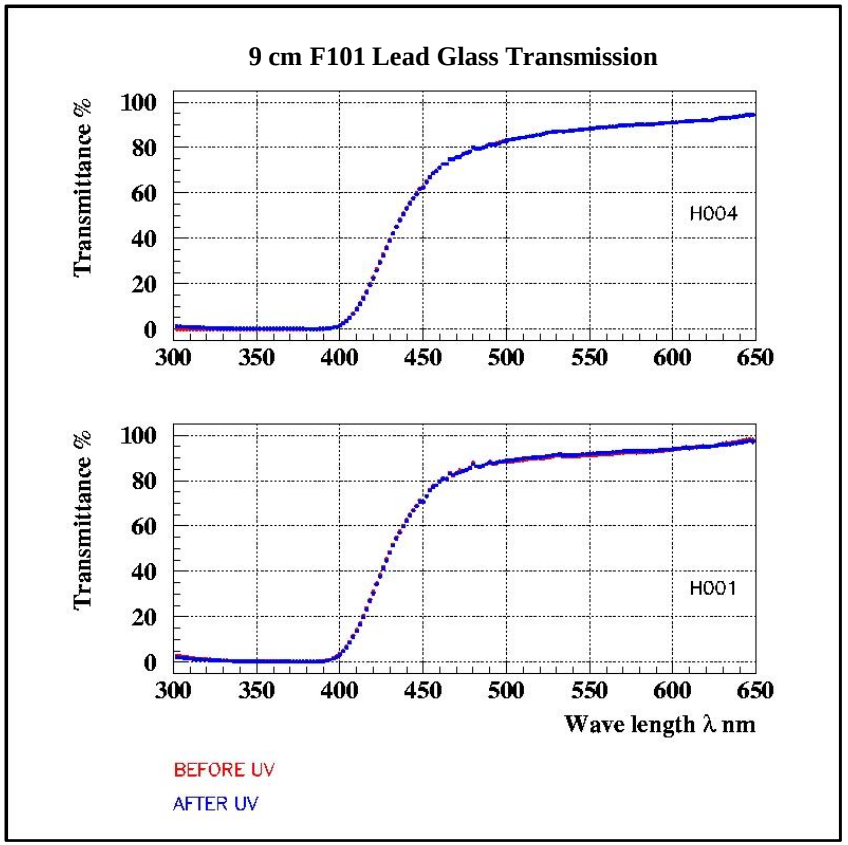


- 10% shift between the two measurements, not explained.
- The spread could be due to density and position variations when measured.

UV curing test

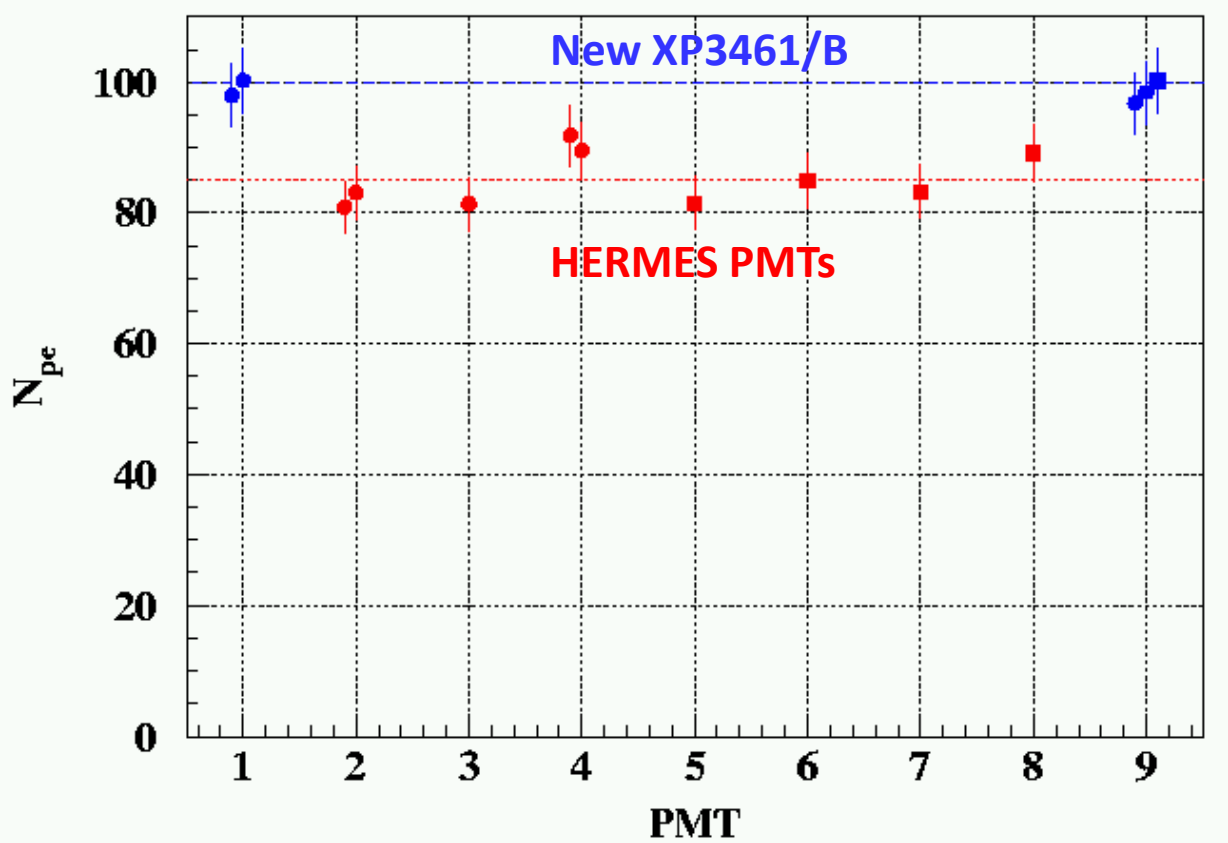
(Difference in BigCal TF-1 and HERMES F101 blocks)





- 5 days UV radiated , λ = 200 – 400 nm
- Strong curing effect on TF-1, almost no effect on F101
- 2 krad dose radiation degrades transmittance of F101 blocks by less than 1%
- F101 ~50 times less sensitive to radiation damage than TF-1

PMT QE tests



- Blue LED light, 470 nm, fixed intensity
- Little photocathode degradation

Summary

What we know so far, what is accomplished

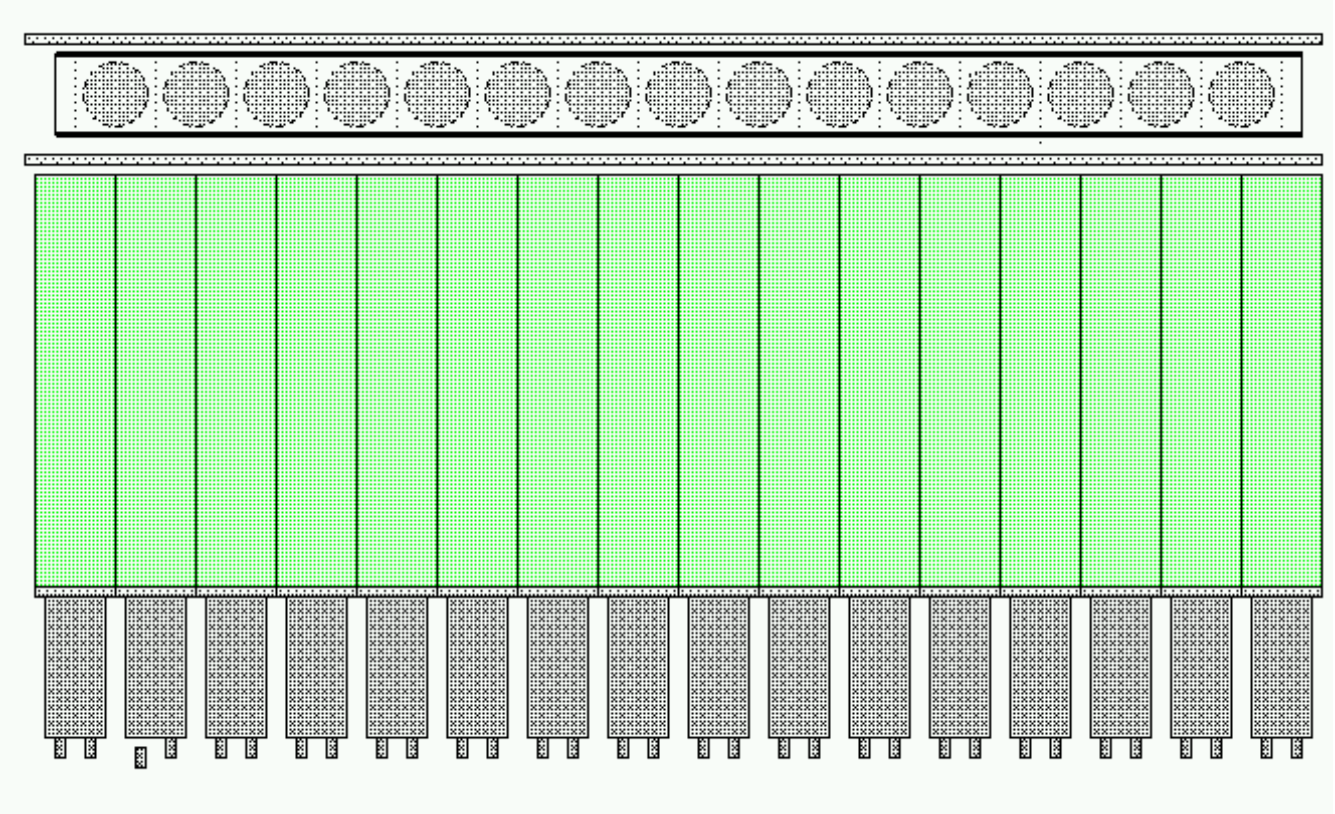
- 10 tested blocks from HERMES have good transmittance.
- 7 tested HERMES PMTs have good Quantum Efficiency, close to brand new XP3461/B.
- In HERMES PMTs were operated at HV ≤ 1.8 kV (gain ~$1x10^6$, good for 5-10 GeV energy range).
- HERMES PMTs and HV bases have been successfully tested for up to HV ~2.4 kV.
- HERMES never changed any PMT, HV base or block during its operation. Technically this was impossible.
- We are close to have final design for Shower and Preshower parts.

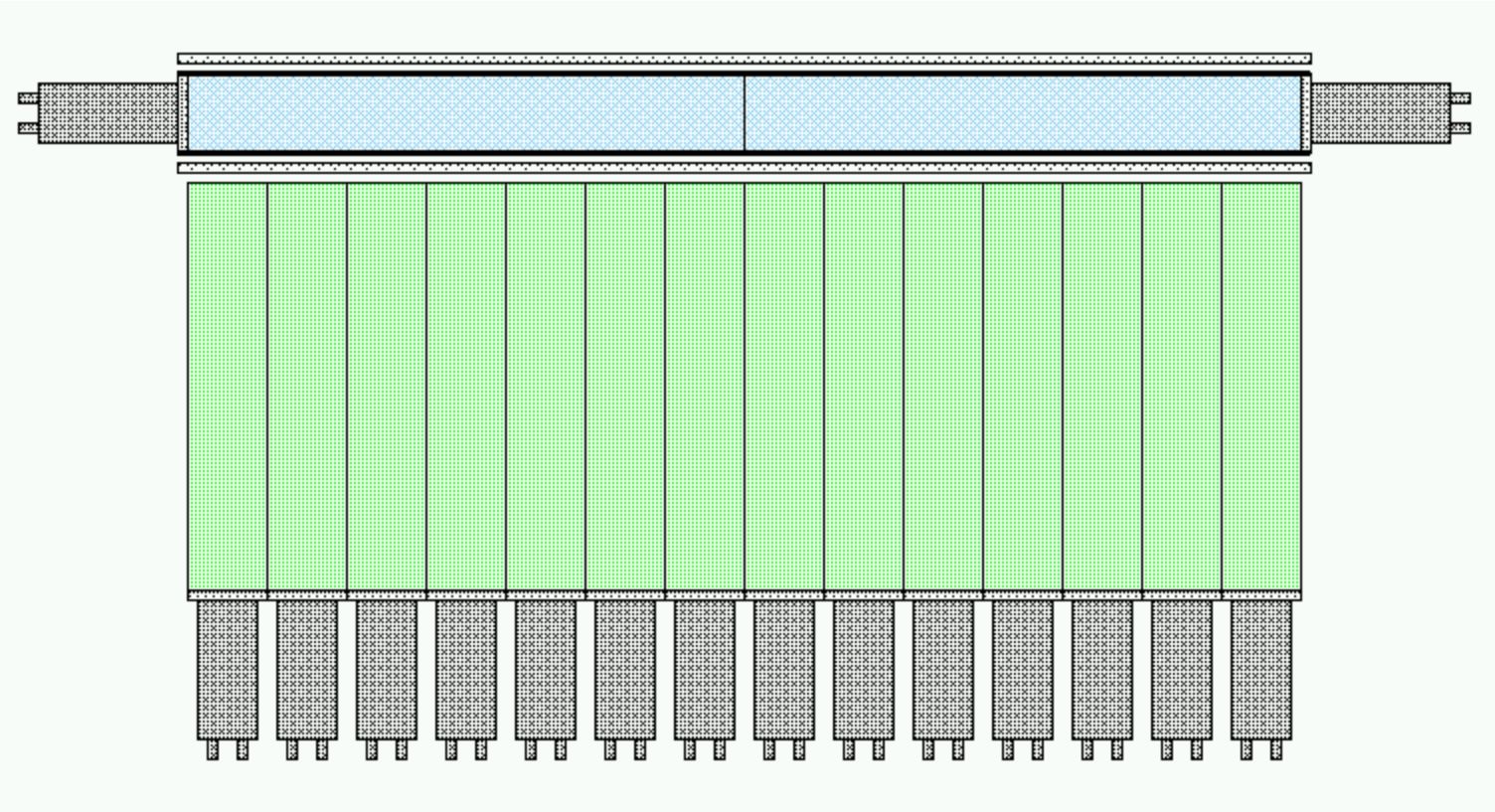
Summary (continued)

Upcoming works

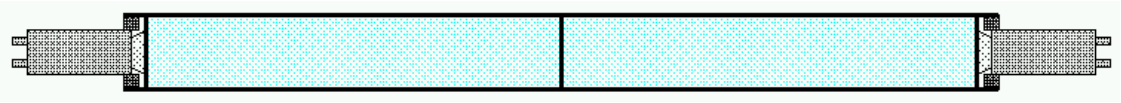
- Check HERMES modules under cosmics
- Find a documentation on HERMES HV bases, or recover information from the bases on hand
- Because we can not change a PMT or an HV base in the Shower part during operation (if we keep HERMES blocks as they are), consider an option to replace a whole module (the “brick wall” arrangement?)
- Finalize design for Shower and Preshower Parts (taking into account the support structure in detector hut)
- Compile the list of materials for block refurbishment, to be ordered if finances are available
- Select the best modules for SHMS Preshower
  - Block transmission measurements
  - PMT QE and gain tests

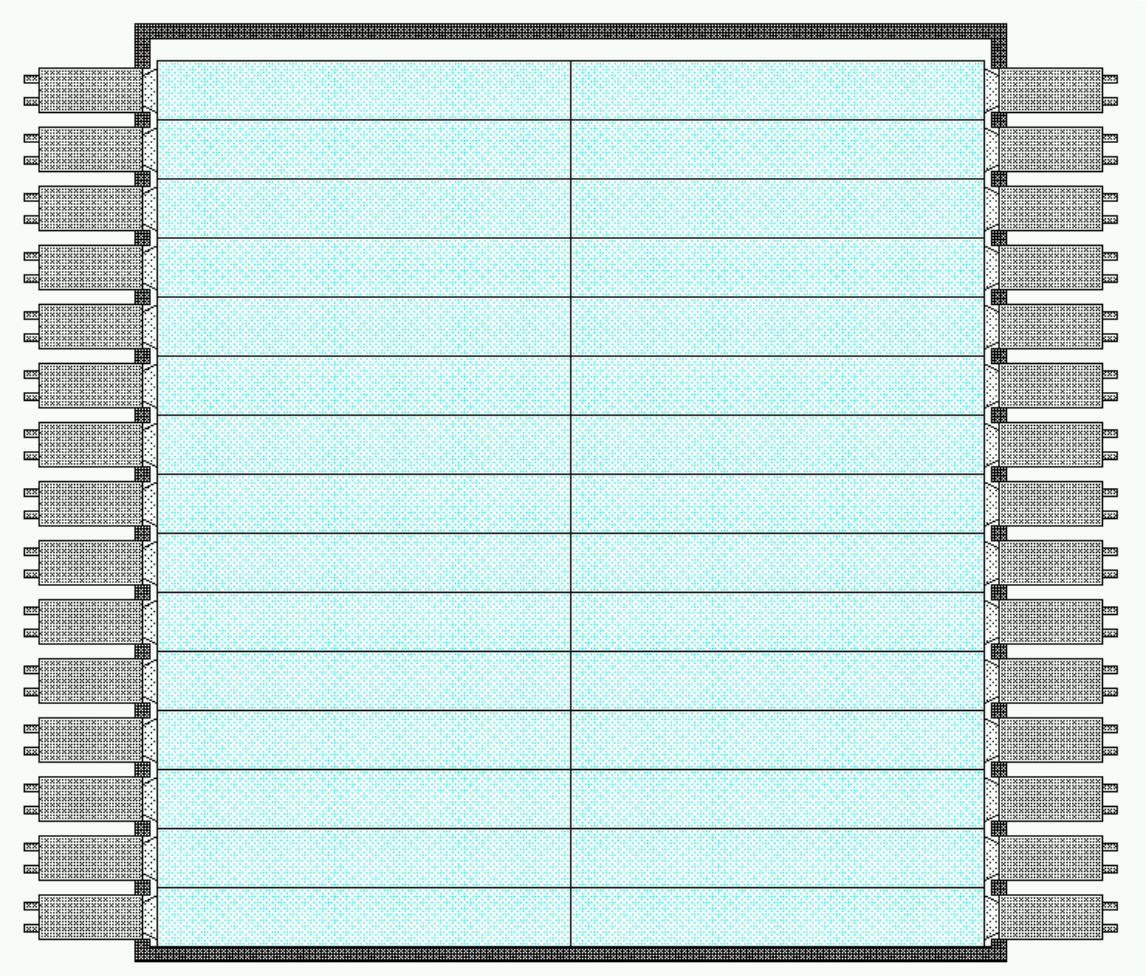
Back-up slides

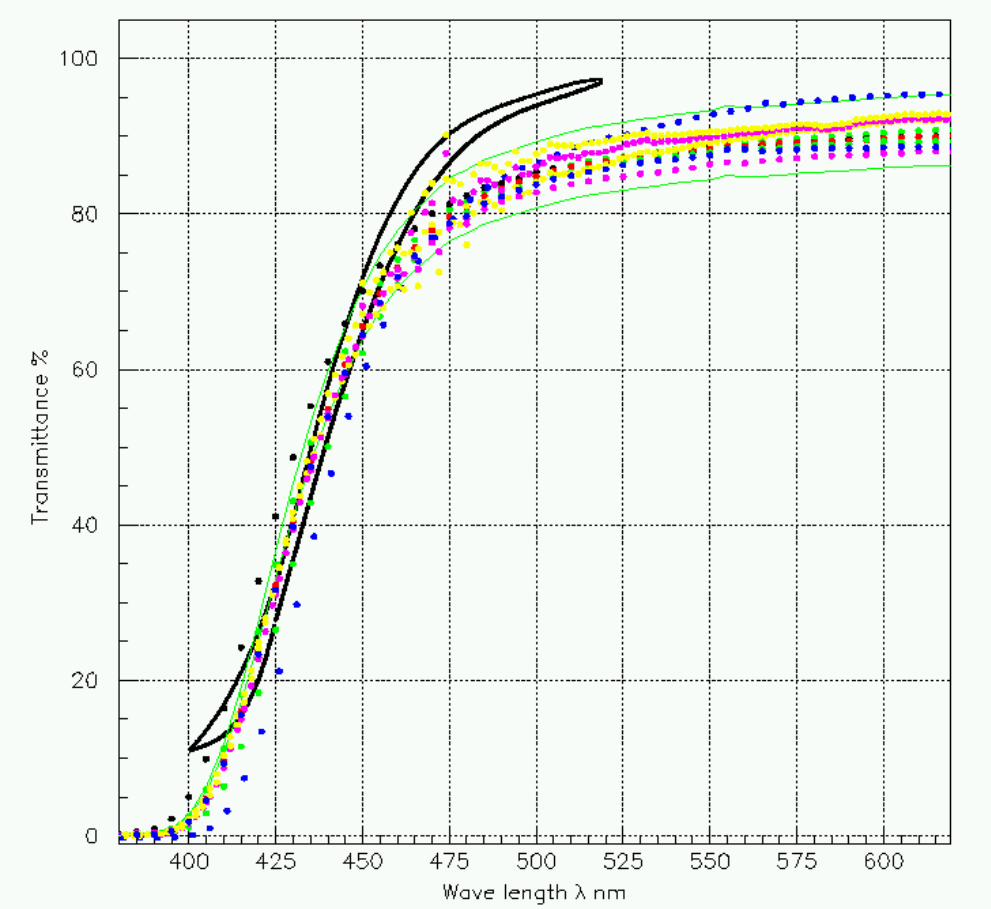




SHMS Preshower

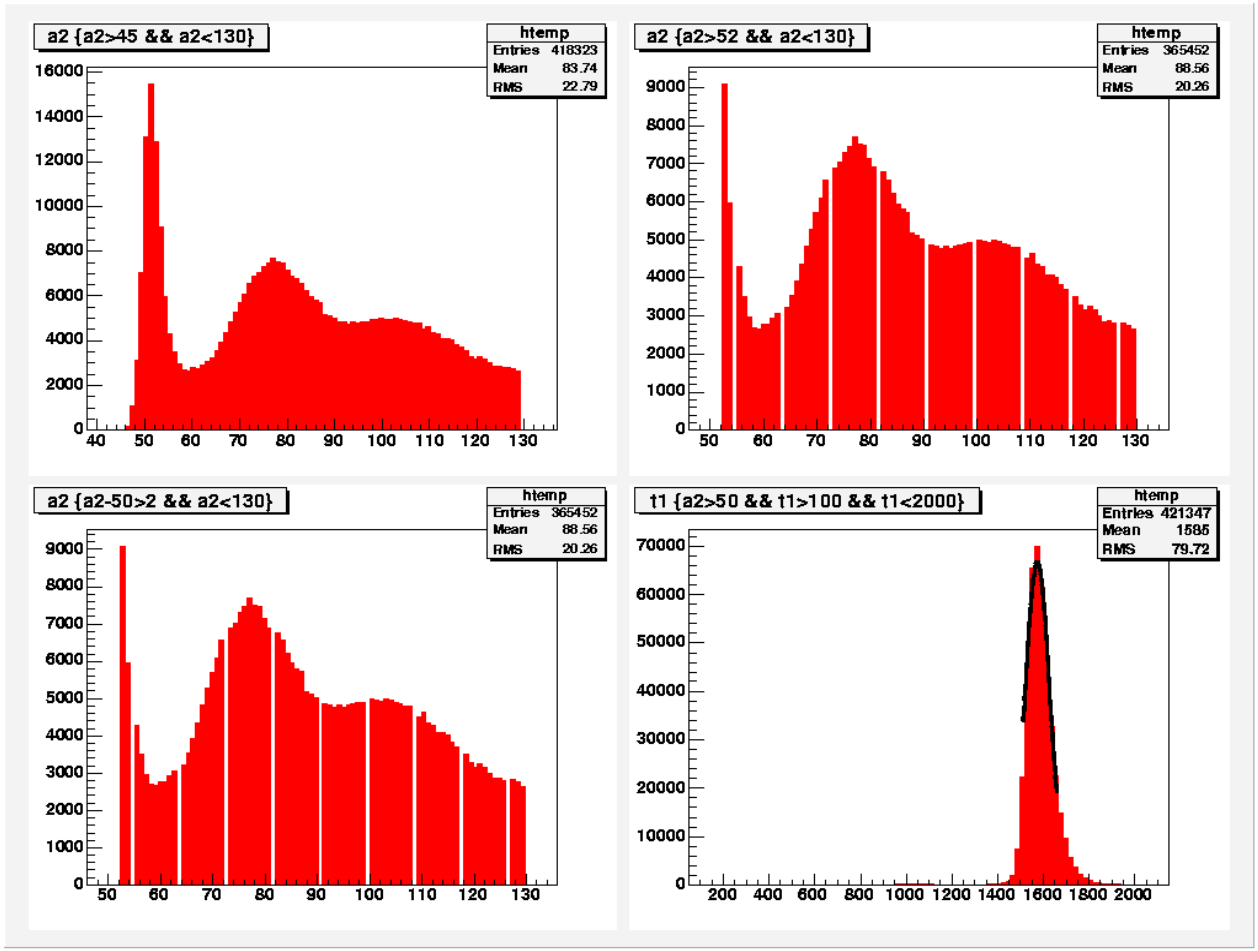





100
80
60
40
20
0
Transmittance %
400
425
450
475
500
525
550
575
600
Wave length λ nm

PMT Gain and QE tests: example spe peak

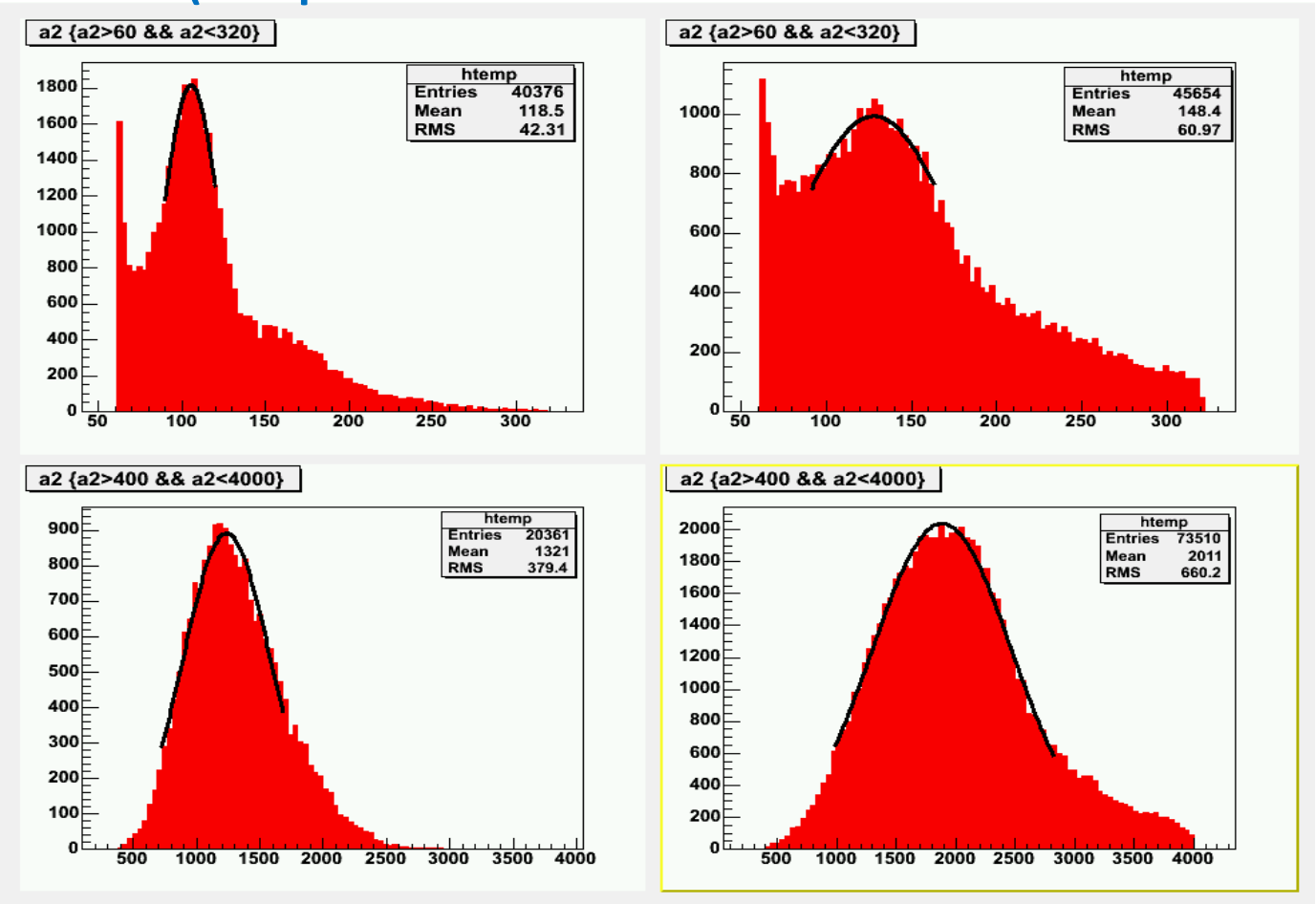
(PMT #0176 from HERMES block #528, HV=2.0 kV)



- SPE peak → 78 – 48 ≈ 30 chan (pedestal subtracted)
- PMT Gain: G ~ 4×10^6

PMT Gain and QE tests: old PMT versus new PMT

(Comparation of HERMES PMT with new XP3461B PMT)



Single photo-electron peak

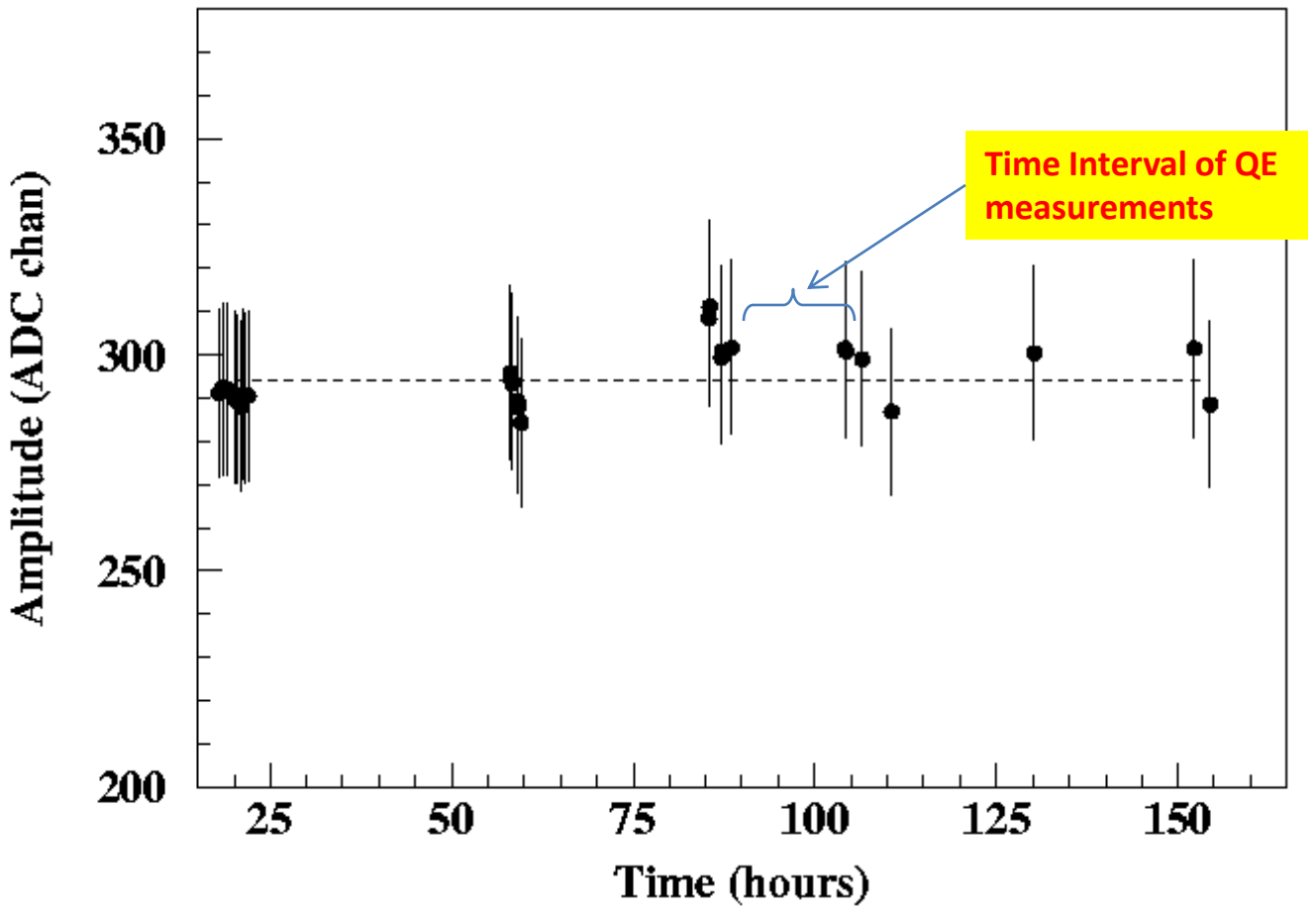
~ 20 photo-electron peak

HERMES PMT # 0176

New PMT XP3461B #861

- **At a given light intensity the Number of photoelectrons Npe = (A-ped)/spe .**
- **Quantum Efficiency of this particular PMT from HERMES calorimeter is as good as of new XP3461B.**

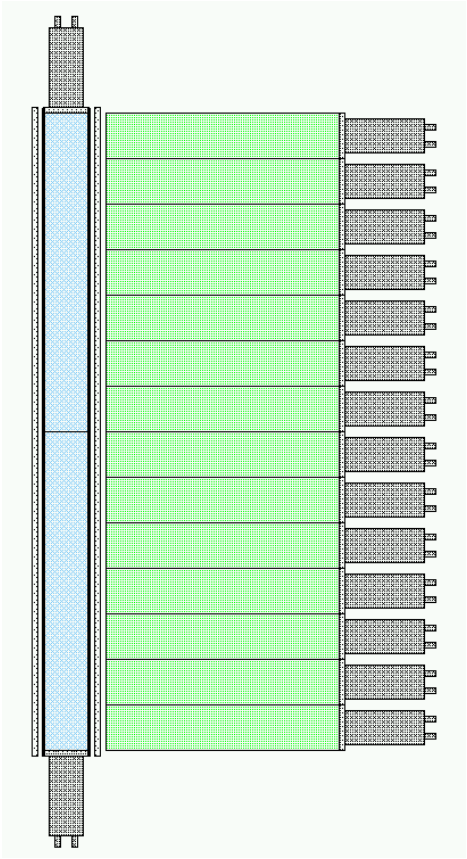
PMT Gain and QE tests: LED Stability test



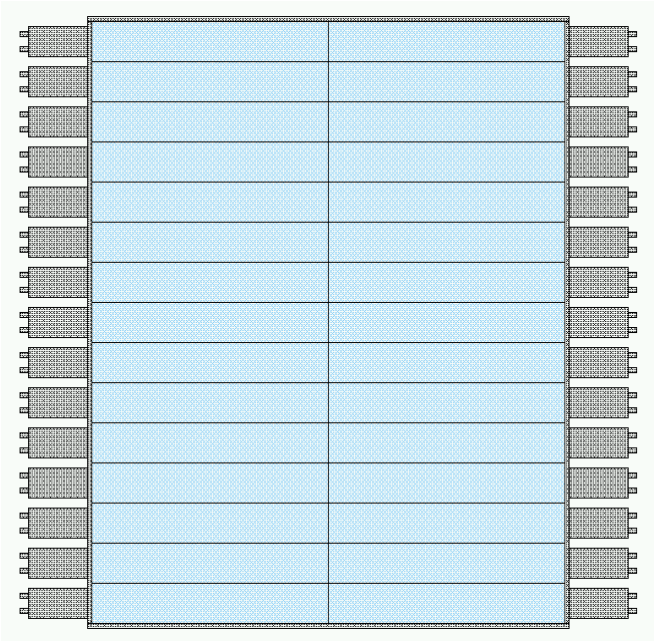
- LED stability and data reproduction have been tested.
- Light intensity before and after measurements is nearly constant.

SHMS Calorimeter: Preshower + Shower

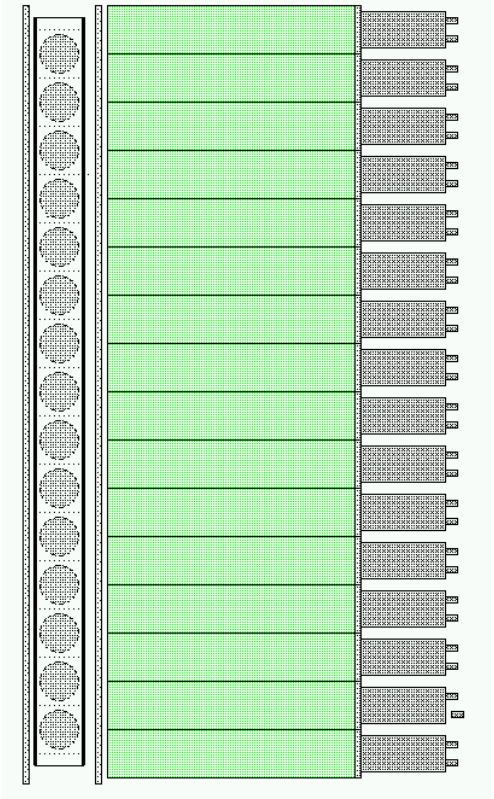
Top view



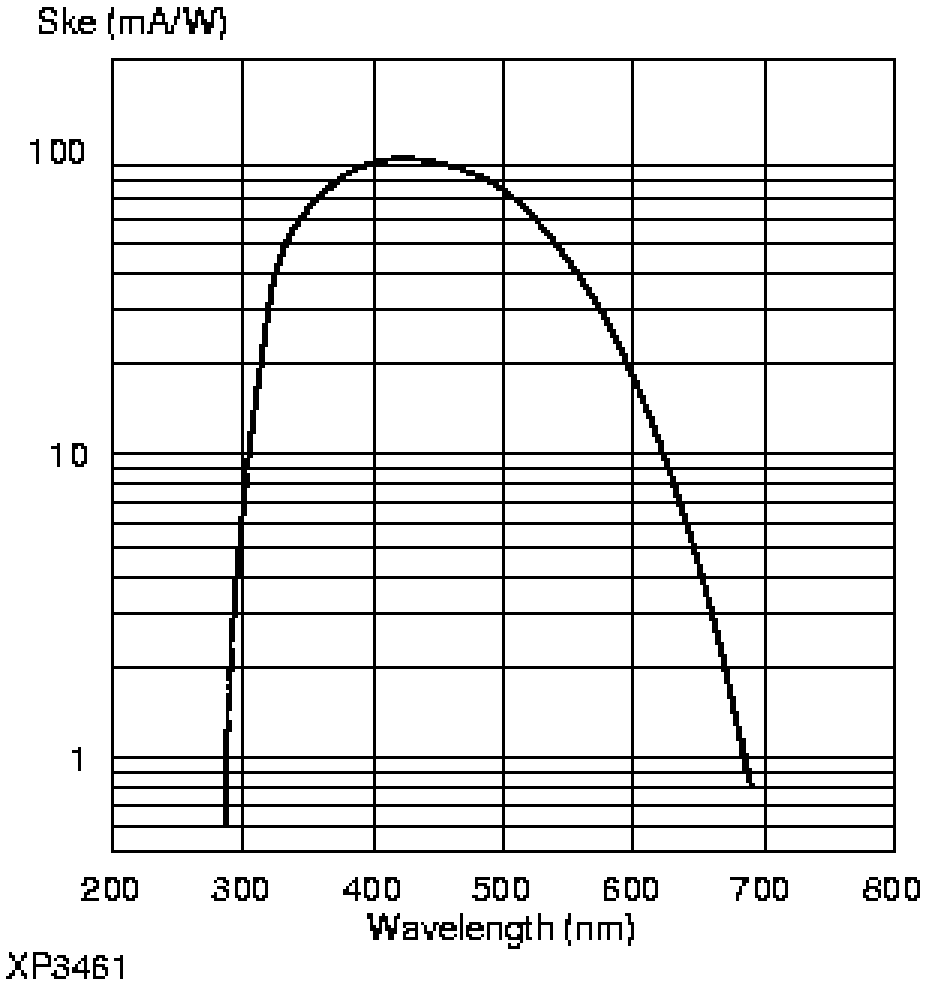
Front view



Side view

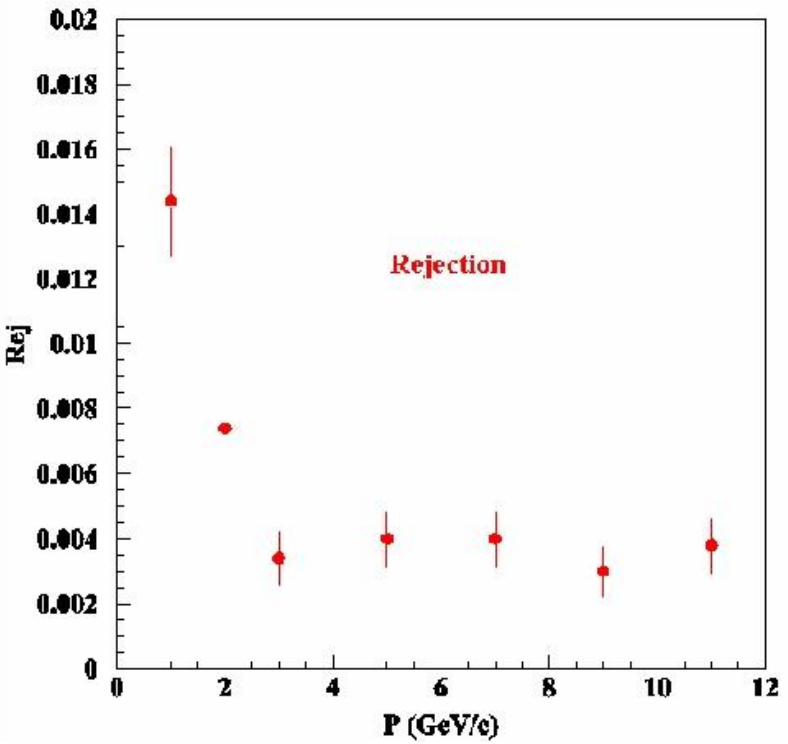


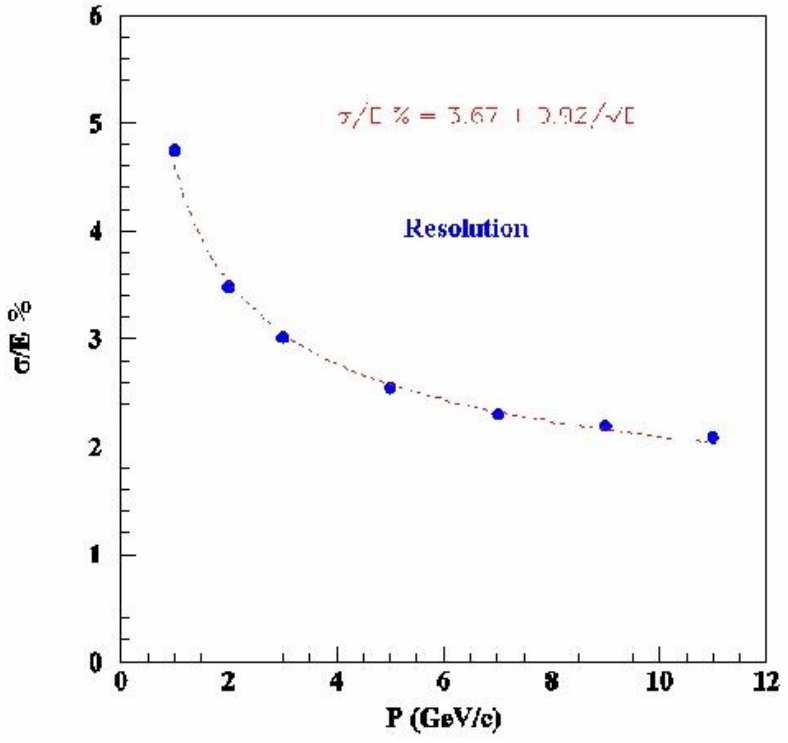
Photonis XP3461 Radiant Sensitivity



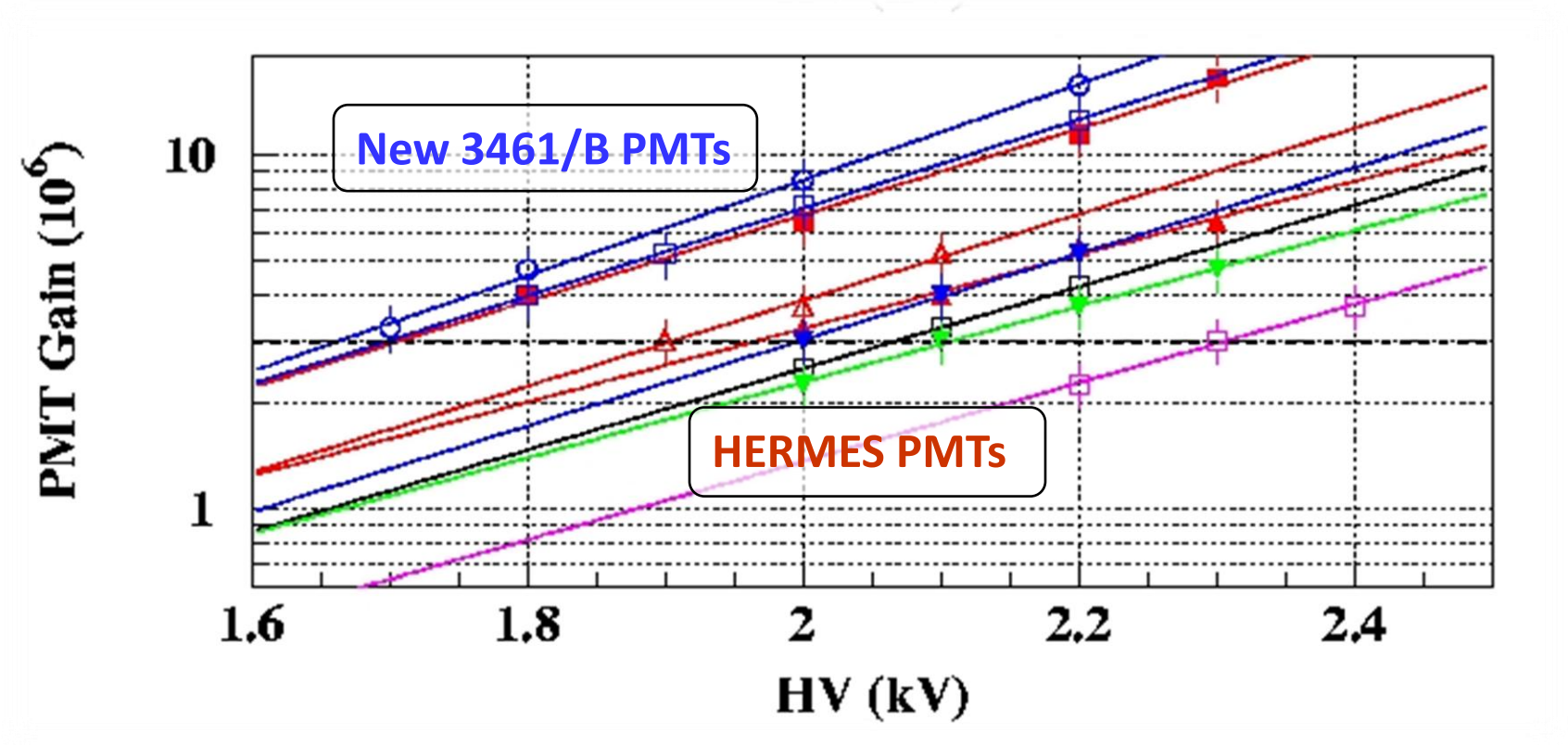
Energy Resolution and π^- rejection
Version 3a: Shower(F101)/Preshower(TF-1)

Energy resolution of the calorimeter (F-101 Shower and TF-1 Preshower):
$\sigma/E=3.67+0.97/\sqrt{E}$. Pion rejection factor at 98% electron detection efficiency for e^- : ~ 4×10^{-3} for P> 2 Gev/c





PMT Gain measurements



- PMT gains obtained by means of spe measurements
- HERMES operated in low gain range, 1.28 ≤ HV ≤ 1.64 kV

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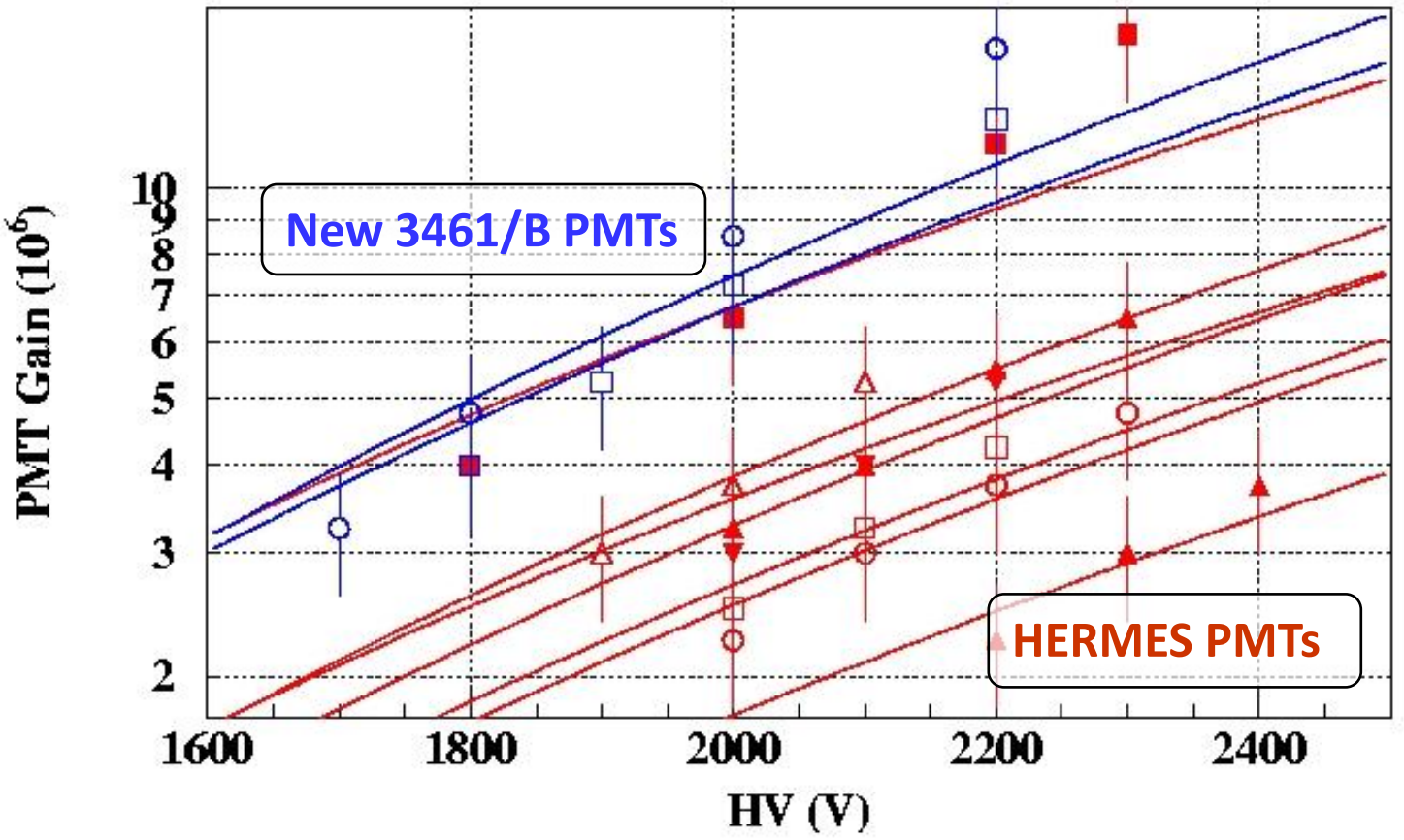

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